

**Digital Trunked Radio
Communications Upgrade
at Lawrence Livermore National Laboratory**

Project Management Plan



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Introduction

This document is the management plan for the Multi-Site Trunked Radio project, a digital trunked radio communications upgrade for the Lawrence Livermore National Laboratory (LLNL) and LLNL Site 300, with possible extensions to Lawrence Berkeley Laboratory and other Bay Area Department of Energy (DOE) facilities. Prepared in accordance with pertinent directives contained within Attachments II-4 and II-5 of DOE Order 4700.1, this plan details management organization, work breakdown structure, documentation, and review practices for the duration of the project. This report also summarizes project cost. Full cost derivations can be found in the companion Conceptual Design Report (LLNL document UCRL-AR-118778; revised October 1994).

This project is a telecommunications acquisition involving the lease-to-own (LTO) procurement of equipment and services only; no construction of buildings or facilities is proposed or required. Also, the project is neither a "major system acquisition" nor a "major project" as defined by DOE Order 4700.1. Thus, many specific directives contained within the order do not apply to management of the Multi-Site Trunked Radio project. The project team has attempted to follow the provisions of the order as closely as possible while recognizing the existence of a gray area among DOE orders pertaining to project management, orders pertaining to telecommunications systems, and the DOE *Radio Services Procedural Guide*, part of DOE Order 5300.1C.

Objective

The project objective is to replace all current radio systems and equipment with a new, centralized communications backbone that combines two approaches for conserving valuable radio spectrum. Used as part of a technologically advanced system, these approaches—digital modulation and a channel-sharing and reuse technique called trunking—will relieve channel congestion, bring the Laboratory into compliance with recently enacted spectrum-conservation legislation, provide a solid management tool for controlling the use of radio transmission equipment, and satisfy LLNL communications needs well into the next century.

The project scope encompasses specifically the communications backbone, which is defined as the permanently installed equipment that is prerequisite for a large number of widely dispersed portable and mobile radios to operate as part of a coherent, well-managed system. The system will be designed to meet the needs of user organizations, to interface effectively with non-LLNL radio systems (such as mutual aid channels, and city and county radio systems), and to comply with applicable DOE orders and environmental safety and health regulations. User needs and interface requirements will help determine the required system features. These will be spelled out in a project functional requirements document that, in turn, will be incorporated into the request for proposals and bid. The winning bidder shall provide a turnkey system consisting of all hardware, software, and vendor services necessary to satisfy the project functional requirements. When complete, the backbone shall provide full two-way radio coverage at Livermore, at Site 300, and within off-site areas that have been identified as critical in the functional requirements. LLNL programs and user groups will be responsible for specifying, budgeting, and procuring field equipment (mobile and portable radios) out of operating budgets. Field unit budgeting and scheduling is thus outside the scope of this project; however, the field unit price will be considered as part of the request for proposals (bid), and prices will be fixed for an agreed-upon period after contract award.

Project completion is scheduled for the second half of fiscal year (FY) 1997. The project will be considered complete, and the final milestone achieved, when operational and performance tests are completed and all user groups have fully migrated to the new system. All phases of the project will be conducted in accordance with applicable federal requirements [in particular, those of the DOE and the National Telecommunications and Information Administration (NTIA), which regulates use of the radio spectrum by federal agencies] as well as state and LLNL requirements.

Cost Summary

The Multi-Site Trunked Radio project is managed to a total estimated cost of \$8.059 million. This sum is projected to cover all LLNL and vendor costs for procurement, installation, and activation of the system backbone; if circumstances outside LLNL management control arise that substantially increase costs for vendor-supplied equipment or services, the project scope will be reduced as necessary to maintain the original cost estimate. Table 1 summarizes the major contributors to the total estimated project cost, while Table 2 is the cost summary plan by work breakdown structure number and year. The conceptual design report derives and discusses each item in detail; this section will highlight key assumptions made in deriving the cost estimates.

Tangible backbone equipment, which includes permanently installed backbone hardware as well as dispatch consoles, remote site equipment, and specialized test equipment, will be procured through lease-to-own (LTO) financing. The LTO arrangement—which permits use of operating rather than capital dollars—was necessitated by reductions in LLNL Defense Program allocations for institutional improvements. Regulatory imperatives to convert to spectrum-efficient technologies, coupled with obsolescence of existing systems, led top LLNL management to conclude that LTO financing of next-generation communications infrastructure was the only way the Laboratory could preserve sought-after frequency allocations, immediately relieve channel congestion, and retain the

Table 1. Summary of project costs (dollars in thousands).

Item	LLNL est. cost
Backbone equipment ^{a)}	\$3822
Project engineering (vendor)	671
Project engineering (LLNL)	288
Management and admin. (LLNL)	952
Installation and support	214
Facility upgrades (material)	109
Escalation (1994–1995) ^{b)}	148
Contingency	943
Interest ^{c)}	623
Materiel Procurement Charge	<u>289</u>
Total estimated cost	8059

a) Includes consoles, remote site equipment, and specialized test equipment.

b) LTO items only.

c) Assumes 9% interest for 3 years (36 monthly payments) on \$4.573 million.

Table 2. Summary cost plan and work breakdown structure (FY 1994 dollars in thousands). WBS level 4 items identified in this table are LTO items with an attached labor component.

Task or item by WBS number	Applicable CDR subsections	Cost by fiscal year							Total
		1994	1995	1996	1997	1998	1999	2000	
1.1 Livemore systems									
1.1.1 System engineering and bid (all sites)	4.2.1; 5.3.2	\$56	\$112	\$84	\$28				\$280
1.1.2 Livemore site preparations (material)	4.2.2			37	10				47
1.1.3 Livemore installation/escorts	4.2.3		53	57	30				140
1.1.3.1 Livemore primary system (LTO item)	2.4.1								
1.1.3.2 Livemore primary voting (LTO item)	2.4.2								
1.1.3.3 Livemore backup system (LTO item)	2.4.3								
1.1.3.4 Livemore consoles (LTO item)	App. A								
1.1.3.5 Microwave and fiber links (LTO item)	App. A								
1.2 Site 300 systems									
1.2.1 Site 300 site preparations (material)	4.2.2		42						42
1.2.2 Site 300 installation	4.2.3		22	22					44
1.2.2.1 Site 300 primary backbone (LTO item)	2.4.4								
1.2.2.2 Site 300 voting (LTO item)	2.4.4								
1.2.2.3 Site 300 backup system (LTO item)	2.4.5								
1.2.2.4 Site 300 dispatch console (LTO item)	App. A								
1.2.2.5 Microwave and fiber links (LTO item)	App. A								
1.3 Remote sites									
1.3.1 Remote site preparations (material)	4.2.2			20					20
1.3.2 Remote site installation	4.2.3		15	10	5				30
1.3.2.1 Mt. Diablo site (LTO item)	2.4.6								
1.3.2.2 Crane Ridge site (LTO item)	2.4.6								
1.4 Management and administration									
1.4.1 Project management (LLNL)	3.2.2; 4.2.7; 5.3.1	100	232	232	116				680
1.4.2 Project documentation	4.2.7; 5.3.1	20	38	38	19				115
1.4.3 Training	4.2.7; 5.3.1			32	32				64
Payments									
Project overhead	5.3.1	36	26	26	13				101
Project contingency	5.5		73	267					340
Material procurement charge	5.1	4	7	278					289
Vendor services (milestone payments)	5.1			335	336				671
LTO Principal	5.1				708	1443	1578	844	4573
LTO Interest	5.1				158	289	154	22	623
PROJECT TOTALS		216	620	1438	1455	1732	1732	866	8059

potential for future expansion of communications capabilities. The Laboratory has also obtained concurrence from the headquarters office of the DOE, which has affirmed that the project is a telecommunications acquisition and has exempted it from the prohibition on operating-dollar lease financing of capital projects outlined in Appendix B of Office of Management and Budget Circular A-11.

Figures shown for backbone equipment and vendor project engineering are LLNL estimates that have been validated against detailed, formal price quotations provided by Motorola Communications and Electronics and Ericsson General Electric. These are the only two firms presently capable of producing the complex hardware and software backbone required for a trunking system. Both manufacturers have broken out their charges for project engineering and design separate from their equipment estimates. This distinction is important because lease-to-own financing can normally be obtained only for tangible pieces of hardware, not for system design, engineering, software licenses, or other intangible services that could not be reclaimed in the event of default. Historically, when large communications systems were procured, manufacturers would either identify the cost of design and engineering services as discrete items in their final bids or would fold the cost of intangibles into the prices quoted for equipment. Therefore, making assumptions about how the vendor service charge is to be paid affects assumptions made about the amount to be financed, hence the total interest cost and the amount and timing of payments. The project team has assumed that intangibles are specified separately, that intangibles cannot be financed as part of the lease contract, and that intangibles are to be paid for with operating dollars at agreed-upon milestones during system installation and acceptance. Thus, vendor integration and engineering expenses would be paid out of operating funds when costs are incurred, with equipment lease payments commencing upon final system acceptance.

Interest costs and payment schedules shown in tables 1 and 2 reflect assumptions about lease terms and interest rates. A three-year lease term is assumed in the cost summary plan to minimize interest costs. A longer lease term would reduce the annual outlay from the overhead budget, but the additional interest expense would add significantly to the total project cost. Additionally, payments on a three-year lease are for the smallest fraction of the expected equipment service life, thus making the acquisition most economically favorable. However, the final decision on lease term will be made when the procurement contract is awarded.

A lease interest rate of 9%, which represented the federal funds cost of money at the time the conceptual design was prepared, is assumed throughout the cost analysis. Of course, market conditions at the time of procurement will determine the actual interest rate paid. The amount financed, \$4.573 million, includes the LLNL estimated cost of all hardware described in the conceptual design as well as contingency and escalation. This figure is intended to represent a worst-case estimate of equipment cost; therefore, it assumes that the contingency estimated for

the backbone will be fully spent and that equipment prices will increase in one year by 3.78%, the inflation rate used to calculate price escalation.

Cost-Effectiveness Analysis

A cost-effectiveness analysis of the lease-to-own versus capital-equipment purchase decision has been made in accordance with paragraph 3e(2) of DOE Order 2200.1 (January, 1993). Nominal discount rates of 5.0% (3-year) and 5.3% (5-year), as specified in Appendix C of Office of Management and Budget Circular A-94 (dated February 10, 1994, and in effect for the period March 1994 through February 1995) were used to calculate the present value of payments made for three- and five-year terms on a principal amount of \$4.573 million, representing the estimated cost of backbone equipment with contingency and escalation. Interest rates assumed for the borrow transaction ranged from 8.55% (origination fee: 1.69%) to 10.25% (origination fee: 0.5%) and were representative of the rates available to LLNL from large institutional lenders at the time the analysis was prepared.

The analysis shows that the decision to lease adds an amount ranging from \$324 thousand to \$391 thousand to the backbone equipment price in 1994 dollars for the three-year term. This is a small price to pay, however, if one considers the consequences of delaying the project the two or more years needed to reseek line-item funding (which had been sought by the project team but was dropped at the LLNL top management level as a result of reductions in allocations to the LLNL Defense Program). Over two years have elapsed from the time frequency allocations were requested and the time all licenses will be received. Without a secure funding commitment from LLNL and DOE, these allocations would have to be relinquished, with no hope for reclamation. Critical radio systems, including those used for safety of the public at large, use wideband equipment that has reached or exceeded its designed life expectancy. If the current repair/replacement rate for mobile and portable radios continues, the existing Safeguards and Security and Plant maintenance radio systems are projected to be rendered unusable in early FY 1997. Replacement with wideband radios is precluded by NTIA regulations after January 1, 1995. Narrowband conventional (nontrunked) radios would be incompatible with existing equipment, thus necessitating the replacement of over 1000 units at a cost approaching that of a trunked system but without the spectrum-conserving benefits of trunking. Such a move would also be at odds with DOE memoranda that specifically require the use of trunking systems at facilities such as LLNL where a large population of radio users is concentrated in a local area. Also, by obtaining a vendor price commitment early in the project, the Laboratory frees itself from the uncertainty of possible inflation- or market-induced price increases. Finally, any cost differential will narrow to reflect further inflation-induced erosion in the value of money because lease payments will not commence until well after the final price has been negotiated and equipment received, a period of at least one year.

Management Organization and Responsibilities

Two organizations are key in managing the Multi-Site Trunked Radio project: the Oakland Operations Office of the U.S. Department of Energy (DOE) and the Lawrence Livermore National Laboratory (LLNL), managed by the University of California for the DOE. Figure 1 illustrates the relationship between these organizations. It is anticipated that detailed project management will be conducted from LLNL under the authority of the Livermore Project Manager (LPM), C. E. Davis, who in turn will receive general direction and advice regarding compliance with DOE directives from the DOE-OAK project manager, D. Burks. The LPM will chair a steering committee composed of representatives from key LLNL user groups. The steering committee will serve as the primary interface between system users and the project team, which includes technical support staff from the LLNL Radio Services organization, as well as the project manager, project coordinator, technical writer, local resource support personnel, and software manager. Figure 2 depicts the LLNL project team. The remainder of this subsection delineates in more detail the scope and authority of organizations and individuals.

DOE-OAK

The Oakland Operations Office is responsible for administering DOE contract W-7405-ENG-48, under which the University of California manages LLNL and under which the Multi-Site Trunked Radio project will be carried out. The DOE-OAK Information Management Division has overall responsibility and accountability for the project.

The DOE-OAK office is responsible for authorizing the project and for verifying progress and cost control. The DOE-OAK project manager will carry principal DOE responsibility for local monitoring of project costs and schedule and for maintaining an appropriate level of communications with the DOE-HQ project office and the LPM.

The responsibilities of DOE-OAK are to:

- Authorize the project through the DOE-OAK directive process.
- Participate in the preparation and approval of the final management plan.
- Administer DOE project management responsibilities, including, but not limited to project status reporting, performance reviews, and reviews of yearly cost estimates and schedule updates.
- Review and approve project management and technical baseline documents as required.
- Participate in and attend project reviews as needed.

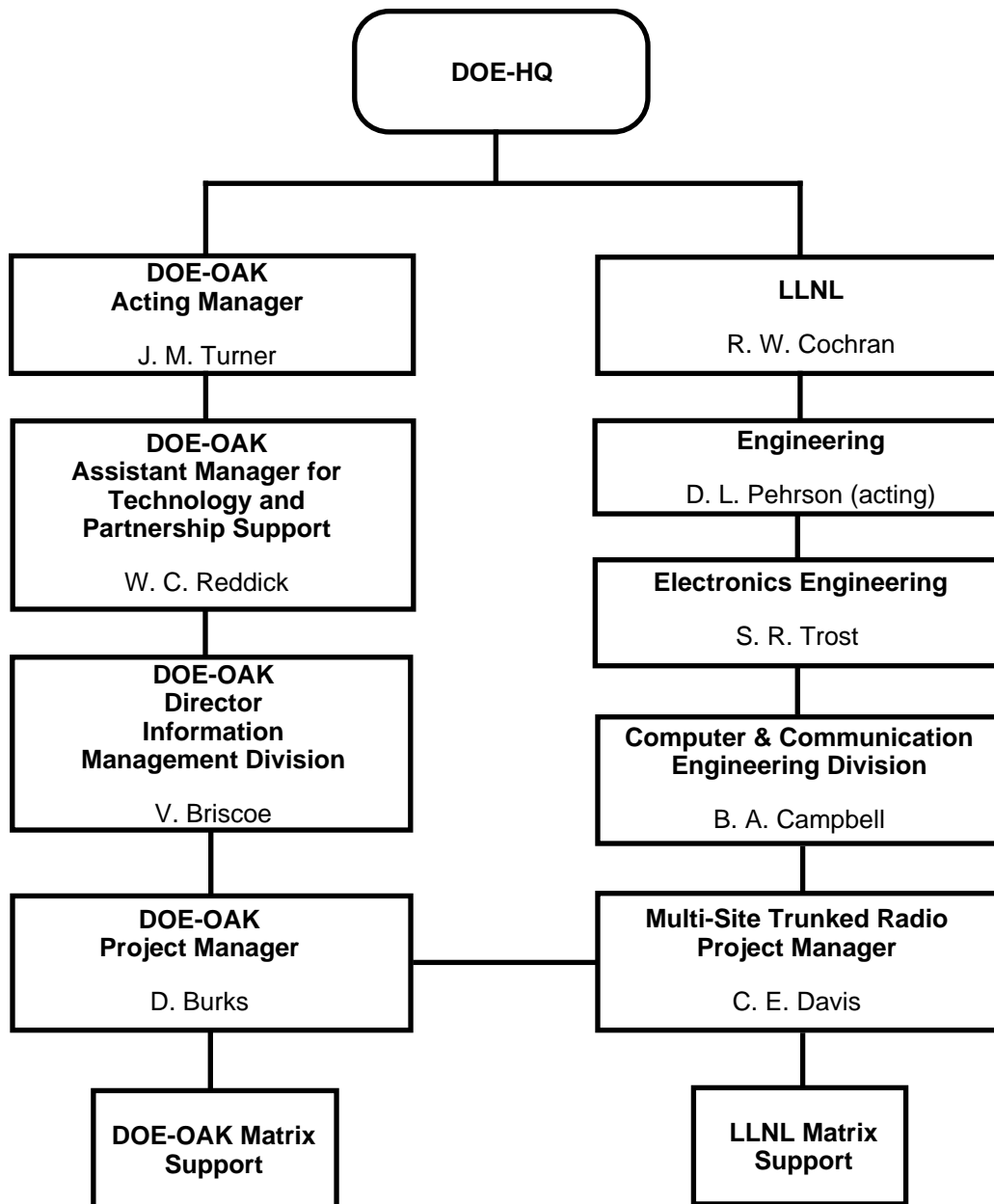


Figure 1. Organization chart showing relationships among key LLNL and DOE project management personnel.

LLNL

LLNL is responsible for project management, design, installation, and operation. The project is conducted under the direction of the LPM, with specialized assistance from disciplines provided by project team members and by members of the steering committee.

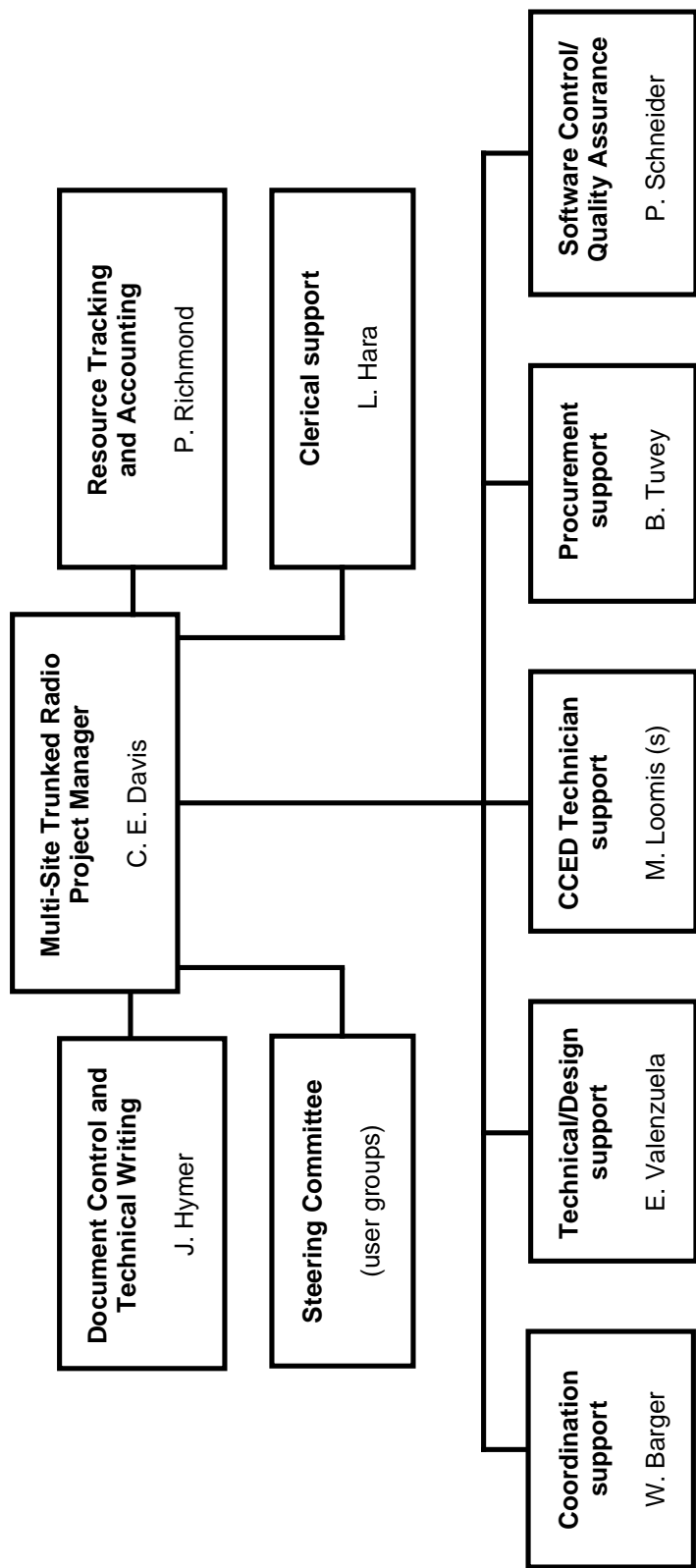


Figure 2. Organization chart showing key LLNL players for the Multi-Site Trunked Radio project.

LPM

The LPM has lead responsibility for initiating action to resolve problems that can cause a significant delay in schedule, a change in costs or contingency allocations, or a significant deviation from approved technical baselines. He will be responsible for successful completion of the project within the approved costs, schedules, and technical performance requirements. The LPM will select team members; provide project direction; control budgets, costs, and schedules; and will be responsible for quality assurance, change controls, contingency management, and compliance with management plan requirements and regulatory directives. The LPM and project steering committee will together develop the initial functional requirements; from these requirements the project technical team will develop the request for proposals (RFP) and subsequent procurement specification. The RFP will be used to invite competitive bids from manufacturers; the procurement specification will define in detail the turnkey system to be provided by the winning bidder.

Under the direction of the LPM, the vendor project engineer (VPE) will be responsible for installation of all backbone system equipment and computers. The LPM and VPE together will perform system checkout and acceptance tests as detailed by, and to verify conformance with, technical specifications. The VPE is a critical member of the project team, and the LPM and VPE will maintain close contact through regular meetings and communications for the project duration. To maintain project continuity, the vendor will be expected to assign the same VPE for the course of the project. After acceptance, the backbone equipment will be covered by warranty, under which the seller will perform major repairs and upgrades. LLNL maintenance personnel will also participate in installation and maintenance during the warranty period to gain familiarity with the system. LLNL personnel will install mobile radios; programs and user groups will be responsible for purchase of mobile and portable radios. Technical training of maintenance personnel and the system manager will be by the seller, while user and dispatcher training will be conducted by the LLNL project team.

As shown in Fig. 1, the LPM reports to the division leader of the Computer and Communications Engineering division of the Electronics Engineering directorate. The division leader is responsible for all manpower within the division and for providing LLNL institutional support.

Steering Committee

As indicated at the beginning of this subsection, a steering committee will be established to serve as the primary interface between system users and the project technical team. The steering committee concept is intended to reflect the view that the project management organization should be as responsive as possible to user needs. This committee will play a key role in developing functional requirements, preparing the procurement specifications, and making decisions that affect system

operation and management. The committee provides a mechanism to ensure that user requirements, concerns, and expectations for system functionality are met.

The steering committee, to be chaired by the LPM, will consist of one representative and an alternate from each major user group. At present, the following major user groups will be represented: Safeguards and Security Department, Fire Department, Plant Engineering, the Emergency Preparedness Program, and Site 300 administration. However, the LPM will retain the authority to add members when deemed necessary. The steering committee will hold regularly scheduled meetings at intervals sufficient to achieve project milestones.

Primary responsibilities of the committee are to:

- Assist in development of the functional requirements.
- Approve scope changes that could affect system functionality.
- Approve the migration plan.
- Approve project documents relating to functionality, operation, and system management.
- Participate in development and review of procurement specifications.

The LPM, as chairperson, will normally be a nonvoting member of the steering committee. However, the LPM will have responsibility for resolving issues that cannot gain unanimous consent or that result in technical, scheduling, or budgetary conflicts. Meeting minutes will be recorded and distributed to all committee members and will be made available to non-members involved with the project.

Each committee member is responsible for maintaining close contact with his or her organization. The LPM and project team will consider all input from steering committee members as representing the views of the managements of the respective organizations.

Project Team

In addition to the LPM and steering committee, the LLNL effort will use the expertise of the following specialists:

Project Coordinator. The project coordinator reports to the project manager and is responsible for placing, managing, and maintaining records of all procurements related to the project, and for acting as the single-point contact for all procurement requests. In addition to performing the normal duties of a technical coordinator, specific tasks of the project coordinator will include:

- Placing, tracking, and recording all procurement actions. Although he/she may delegate procurements to other coordinators, the project coordinator has ultimate responsibility.
- Maintaining all procurement records for the project and generating regular status reports of all procurement actions. Current status reports are to be supplied to the project manager and project resource support specialist.
- Coordinating project activities with Plant Engineering and other groups, as needed.
- Generating requests and maintaining records for leased switched and unswitched telephone lines and fiber optic cables.

Technical Writer. The technical writer reports to the project manager and is responsible for editing, publishing, and maintaining all documentation for the project, other than system prints and software. Duties include the following:

- Editing all internal and external project reports and related documentation.
- Ensuring that all documentation is properly numbered and released, as per Laboratory and University policy and DOE orders.
- Maintaining a file of all original documents and revisions.
- Providing a system for controlling and tracking the distribution of key project documents.
- Providing assistance in project presentations.

Project Resource Support. The project resource support specialist reports to the project manager and is responsible for maintaining financial records and tracking expenses for the project in a timely manner. The specialist is not responsible for making procurement or major financial decisions. Specific tasks include:

- Maintaining a file of all monthly financial records for the project pertaining to procurements, liens, and costs for LLNL employee and supplemental labor.
- Identifying all expenses from the monthly detail ledgers and helping to resolve any questionable items (defined as any labor or procurement expense item not known to be authorized by the project manager).
- Maintaining a separate spread sheet of expenditures on each WBS item, showing planned vs actual expenses (monthly), and a summary spread sheet showing the combined expenses of all WBS accounts.

- Receiving procurement information from the project coordinator for use in verifying financial reports and estimating monthly expenditures.
- Generating monthly reports to the project manager outlining the financial status of the project (including total amount spent, total available, and other pertinent financial values). These reports may require graphs for use by the project manager in his presentations to the DOE-OAK manager. Year-end reports will also be required each fiscal year.
- Preparing with the project manager cost plans at the start of each year, along with any required updates or modifications.

Software Manager. The software manager reports to the project manager and is responsible for controlling the use and distribution of all software purchased by and for the project, including that used for the field units, backbone system, and any special test or measurement equipment. This individual is not responsible for managing standard commercial software used on office personal computers for routine project business. The software manager's responsibilities include the following:

- Ensuring that all software and copies are properly licensed and distributed.
- Maintaining all original software and documentation, and controlling the use and availability of all copies.
- Maintaining current revisions and revision documentation at all sites and associated machines.
- Publishing in-house documentation, as required, to keep all project team members updated with any new revisions or changes in use.

Scope of Work

The project work breakdown structure (WBS) is shown in Fig. 3. The Level 1 category is the establishment of a narrowband, digital, trunked radio communications system at Lawrence Livermore National Laboratory, as detailed in the conceptual design report. At Level 2, the project is subdivided by location, or in the case of the management and administration element (which applies to the project as a whole and thus cannot be effectively broken out by location), by purpose, as provided by Part B of DOE Order 4700.1. Specific tasks at each location are described at WBS Level 3, with the most complex tasks broken down into Level 4 subtasks.

The critical path analysis logic diagram of Fig. 4 was used to generate the overall project schedule, which is shown in bar chart form in Fig. 5. Figures 6 through 8 break out tasks at each site (Livermore, Site 300, and remote sites) in more detail. Work to be performed within each WBS Level 3 subsection is described in the following paragraphs.

System Engineering and Bid (WBS 1.1.1)

Activities under WBS 1.1.1 apply to the entire system and are grouped under WBS 1.1, Livermore Systems, because the Livermore site is the most complex and because some design decisions made for the Livermore site will dictate design choices for other sites.

The system engineering and bid element consists of five discrete tasks, from conducting radio-frequency field-strength measurements to acceptance-testing equipment after receipt but before permanent installation. The first task is to conduct a field-strength survey, in which a calibrated spectrum analyzer under computer control is used to measure and record field strength intensities of signals on four UHF frequencies. These signals are transmitted from sources at the locations proposed for the main and backup rf locations at Livermore and Site 300. The purpose of the survey is to verify that all areas targeted for coverage are fully blanketed, including interior areas of buildings identified as critical by user groups as well as the road between Livermore and Site 300. In addition to verifying the optimum placement of transmission sources, the survey establishes where satellite receivers should be located to ensure full coverage from low-power portable radios.

Completing the second and third tasks will be a joint effort of the project team and steering committee. The steering committee, to be composed of the project manager and representatives of selected user groups, will help ensure that detailed functional requirements represent user needs. Supplementing these efforts will be interactions between the steering committee and user groups that do not have representatives on the committee as well as meetings with LLNL program

1. MULTI-SITE TRUNKED RADIO PROJECT

1.1 LIVERMORE SYSTEMS

1.1.1 System engineering and bid

1.1.1.1 RF measurements

1.1.1.2 Functional requirements

1.1.1.3 Develop procurement specification

1.1.1.4 Bid/award lease-to-own contract

1.1.1.5 Stage & test equipment

1.1.2 Livermore site preparations

1.1.3 Livermore installation

1.1.3.1 Livermore primary system installation

1.1.3.2 Livermore primary voting system installation

1.1.3.3 Livermore backup system installation

1.1.3.4 Livermore console installation

1.1.3.5 Microwave/fiber link installation

1.1.4 System activation

1.1.5 Test and acceptance

1.1.6 Removal of old systems

1.2 SITE 300 SYSTEMS

1.2.1 Site 300 site preparations

1.2.2 Site 300 installation

1.2.2.1 Site 300 primary backbone installation

1.2.2.2 Site 300 voting system installation

1.2.2.3 Site 300 backup system installation

1.2.2.4 Site 300 dispatch console installation

1.2.2.5 Microwave/fiber link installation

1.2.3 System activation

1.2.4 Test and acceptance

1.2.5 Removal of old systems

1.3 REMOTE SITES

1.3.1 Remote site preparations

1.3.2 Remote site installation

1.3.2.1 Mt. Diablo site installation

1.3.2.2 Crane Ridge site installation

1.4 MANAGEMENT AND ADMINISTRATION

1.4.1 Project management (LLNL)

1.4.2 Project documentation

1.4.3 Training

Figure 3. Project work breakdown structure.

managers. These interactions will include oral presentations to individuals or groups, many of which will be accompanied by a short video program produced at LLNL to describe operation of the system to nontechnical audiences. The project manager and steering committee together will review user input and prepare a functional requirements document that describes the necessary features and capabilities of the trunked radio system in detail.

The functional requirements and Acceptance Test and Standards are two vital components of the detailed procurement specification. The procurement specification, which constitutes the third task in the system engineering and bid WBS element, will be developed with assistance from the LLNL Procurement Department. The Acceptance Test and Standards document will contain criteria and standards for acceptance testing of incoming equipment and the overall system. Upon review and approval of the specification, the project team will enter the procurement phase, which is the fourth task and which includes inviting bids, establishing procedures for evaluating bids, performing the evaluation, and awarding the contract. Placing the contract with the successful bidder, scheduled for November 1995, and obtaining price and delivery commitments will constitute the first project milestone. The procurement cycle shown in Fig. 5 is an estimate based on other large, competitive-bid projects.

The final task of the system engineering and bid element is the staging and acceptance-testing of incoming equipment. The tasks established for this phase, to ensure that all equipment has been received and meets specifications, will be carried out as described in the Acceptance Test and Standards document.

Site Preparations (WBS 1.1.2, 1.2.1, and 1.3.1)

Concurrent with procurement, the project team will perform necessary facility upgrades at Livermore, Site 300, and remote sites. These upgrades involve preparing facilities for new and additional equipment as well as accommodating existing systems without interruptions to users while new racks and utilities are put in place. Although the extent of the modifications and the time needed will not be known precisely until the final system design is completed, the periods shown in Fig. 5 represent the project manager's estimate based on the conceptual design and experience with other large system upgrades. Preparations at both sites will proceed concurrent with development of the procurement specification, thus affording ample time for existing systems to be relocated and upgrades to be completed before new equipment has to be accommodated.

Installation (WBS 1.1.3, 1.2.2, and 1.3.2)

The installation task at each site consists of the installation and checkout of five identifiable subsections of fixed equipment: primary system, primary voting system, backup system, consoles, and microwave/fiber links. Commencement of Site 300 backbone equipment installation, scheduled for February 1996, will constitute the

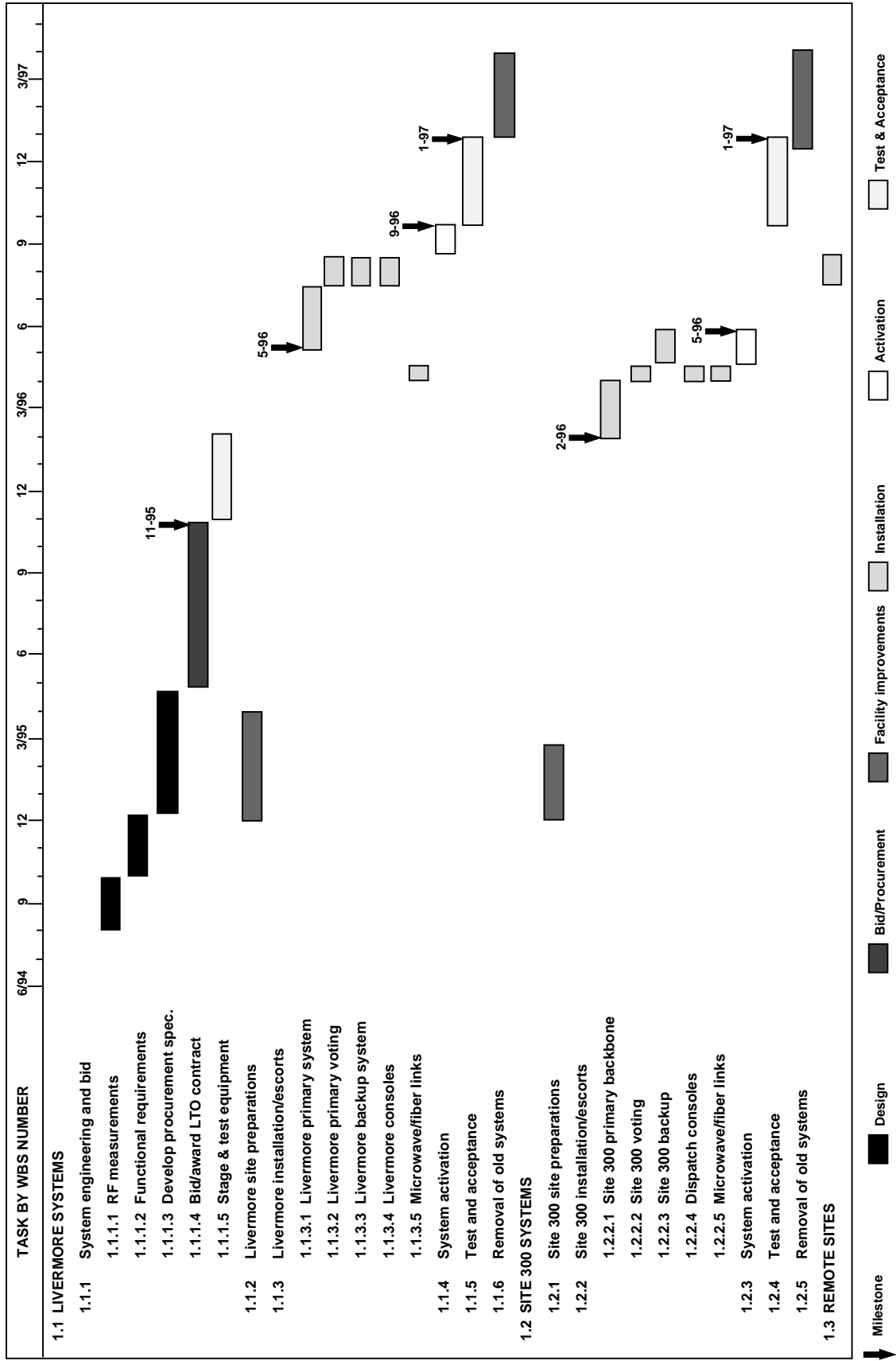


Figure 5. Overall project schedule as of October, 1994, showing milestones and principal activities within each WBS element.

second project milestone; commencement of Livermore backbone installation in May 1996 shall constitute the third milestone. The Site 300 backbone will be installed first so that lessons learned there can be applied to the more complex Livermore system. Installation includes staging equipment, installing in racks, loading controller software, and doing other tasks to make operational tests possible. In addition, translators, channel banks, and other equipment required at remote sites will be installed. Installation work will be performed by the vendor with extensive assistance from the LLNL project team. The time lines specified in Fig. 5 for installation illustrate blocks of time during which installation will be performed. These lines represent intermittent periods of installation, rather than continuous effort. Times shown are based on estimates provided by vendors.

System Activation (WBS 1.1.4 and 1.2.3)

Each backbone subsystem will be activated individually and be thoroughly tested before user groups are migrated from existing equipment. Again, the project team intends to apply lessons learned at Site 300 to Livermore, so the Site 300 system is slated for activation concurrent with installation of the Livermore primary system backbone. Activation of the Site 300 system in May 1996 will be the fourth milestone; activation of Livermore systems in January 1997 will constitute the fifth milestone. Because trunked radios are so much more complex than their conventional counterparts, the Site 300 primary system will be activated as the backup system is being installed. This approach will allow the project team to ensure proper operation and complete coverage without the added complexity of requiring seamless interaction between the main and backup systems at the outset. No critical user groups will rely exclusively on the new system until all backups are in place and proven.

Test and Acceptance (WBS 1.1.5 and 1.2.4)

Upon completion of all backbone installations, the project will enter the test and acceptance phase. During this phase, the project team will verify that all equipment not only works individually (using yardsticks defined in the System Acceptance Test and Standards document) but also works as a coherent system. Successful completion of test and acceptance at both Livermore and Site 300 is the sixth and final project milestone. Technician and system manager training (WBS 1.4.3) may also take place at this time.

Removal of Old Systems (WBS 1.1.6 and 1.2.5)

After the trunked radio system is accepted and all user groups have successfully migrated, old radio systems will be removed and equipment excessed in accordance with established LLNL procedures. Facility repairs or refurbishment necessitated by removal of old systems will also be completed at this time. Finally, vacated frequencies identified in the telecommunications proposal will be returned to the

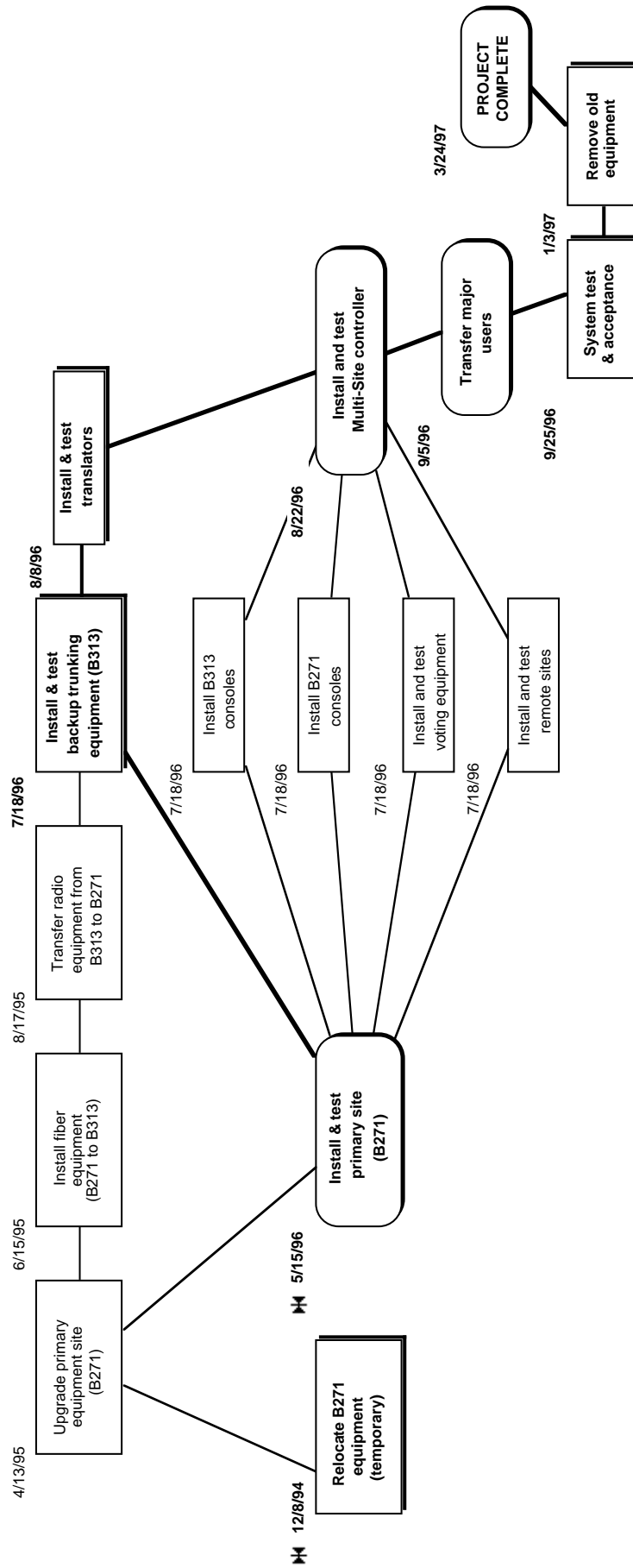


Figure 6. Logic diagram detailing work at WBS 1.1, Livermore Systems.

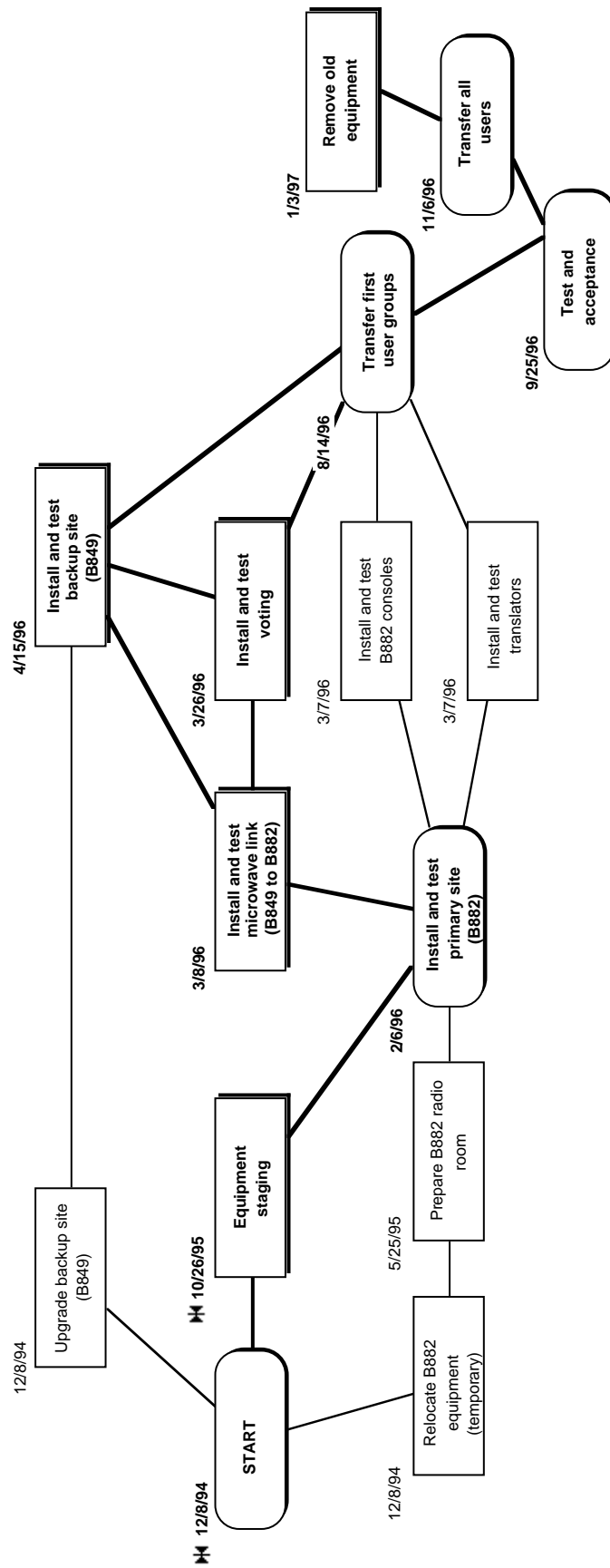


Figure 7. Logic diagram detailing work at WBS 1.2, Site 300 Systems.

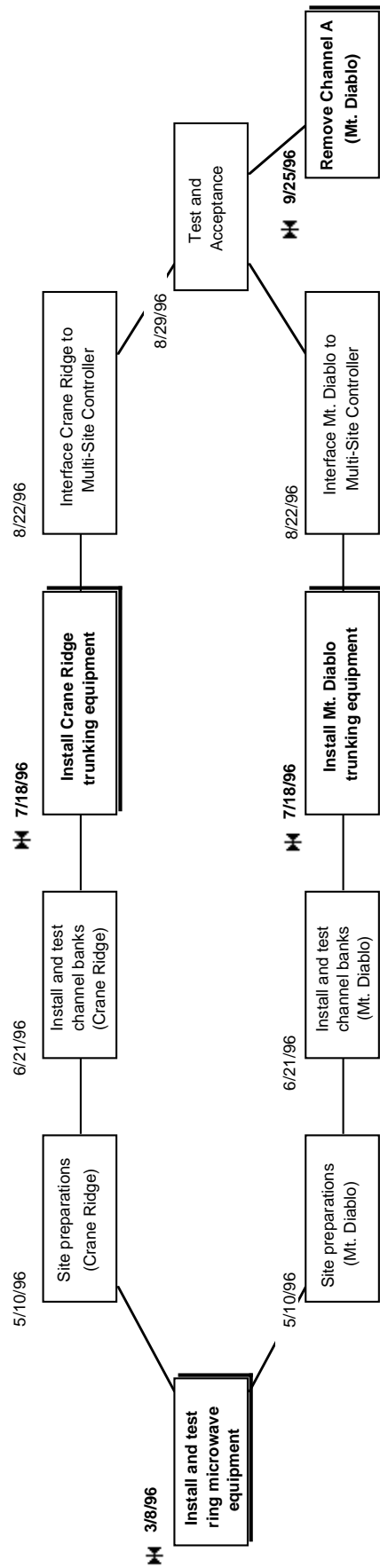


Figure 8. Logic diagram detailing work at WBS 1.3, Remote Sites.

National Telecommunications and Information Administration and licenses cancelled.

Management and Administration (WBS 1.4)

The project management and administration element applies to activities lasting for the entire project and that cannot be effectively identified as belonging to a particular location. Included under this element are activities of the project manager as well as clerical, coordination, and resource tracking support. Also covered is documentation support, which includes preparation of project documents, formal presentations and design reviews, and drafting of system prints.

Project Control

Control of the project will be achieved through formal and informal technical reviews and through the formal approval of baseline documents by LLNL and DOE. The LPM will use standard computer-based management tools for project planning, forecasting, and control. With the aid of these tools, the LPM delineates work elements, forecasts costs and personnel needs, identifies critical-path tasks, establishes milestones, and generates work-flow charts. After approval, the plans serve as the basis for controlling technical progress and cost.

Cost Control

The existing LLNL management information system controls costs through the tracking of all project expenditures and commitments. Costs will be collected and identified by type of expense and cost center. Four cost centers have been established for the project, one for each WBS Level 2 activity. Further cost breakdowns on work packages will be defined as required for detailed planning, assignment, budgeting, and monitoring of work. The cost of completed work will be accumulated and summed upward as directly as possible. Changes within the limits prescribed in the contingency management discussion in this section will be the responsibility of the LPM.

Costs and obligations schedules will be developed for the project from the cost account level. These schedules shall serve as baselines against which cost performance on the project will be measured. The LPM will show actual costs and obligations (monthly and cumulative) in his monthly report to DOE-OAK. It should be noted that some costs are internal to LLNL but are out of the control of the LPM. Such costs include facilities and personnel charges and other forms of overhead. Uncertainties in this area could require changes in funding level if the project objective is to be preserved.

Procurement procedures employed by LLNL and approved by DOE under Contract W-7405-ENG-48 will be used. Standard LLNL controls include signature authority by account number and cost level, as well as monthly reports of procurement activity to LLNL management.

Schedule Control

Schedules will be maintained by tracking performance against designated project milestones shown in Figs. 4 and 5. Schedules will be developed by the LPM and concurred with by the DOE-OAK project manager. Work will be formally scheduled in a manner that will permit all participants to review progress and that will allow for evaluation and corrective action of schedule variances.

Configuration and Change Control

Configuration control will be implemented by a system of approval and change controls within the project that will be in effect from issuance of system requirements to project completion. These controls will consist of

- Review and approval by the LPM of detailed specifications, drawings, and procurement actions.
- Approval by the LPM and steering committee of changes in project scope that could affect system functionality.
- Identification and resolution of “action items” affecting functionality or reliability. Action items will be identified and tracked through written problem/solution reports, which will be completed by individuals responsible for implementing changes and kept on file by the LPM.

The LPM intends to keep the project scope within the total estimated cost outlined in the conceptual design and summarized in this management plan. Therefore, unexpected cost increases outside LLNL’s control may require changes or possible reductions in project scope. Any such changes will be reviewed by the steering committee and, if appropriate, by the DOE-OAK project manager.

Contingency Management

A contingency reserve will be established as an appropriate percentage of uncommitted funds that are used as needed as the project proceeds. Because this project is funded as a lease-to-own acquisition with operating dollars, contingency management is less flexible than it would be for a project funded with capital dollars because all funds must be spent during each fiscal year. Contingency funds for a capital project typically start high, when the number of unanswered questions is greatest, and get smaller as the project progresses; the fund carries from year to year for the duration of the project. However, contingency for operating-dollar projects is allocated and spent yearly. As a general rule, contingency will be distributed as follows:

Priority 1: Fixes for unforeseen problems that will have adverse effects on system performance or project schedule.

Priority 2: Fixes for problems having only minor effects on system performance.

Priority 3: Provide new functions, as defined by the functional requirements as “desired options.”

The LPM, with the advice of the steering committee, will assign priority levels for candidate uses of contingency funds.

Document Control

A project filing and tracking system will be established for managing software and software listings, design data, and publications. The technical writer will assume responsibility for tracking all project publications, while the software manager will track software, software revisions, and software listings. The LPM will retain records of project design data.

Test and Acceptance

System tests and acceptance tests will be conducted on all major subsystems and components to a level of detail sufficient to demonstrate to the project team and vendor representatives that equipment not only works individually but also works as a coherent system. After final tests, the system will enter a “trouble-free performance” test period of at least 30 days.

Documentation, Reporting, and Review

Project Baseline Documents

Several baseline documents exclusive of the procurement specification have been identified as crucial and either have been developed or will be written as the project progresses. In addition to this Management Plan, the project team is responsible for the Telecommunications Plan, Conceptual Design Report, Functional Requirements, Acceptance Test and Standards, and Migration Plan. These documents are described in the following paragraphs.

Telecommunications Plan

A telecommunications plan, required to obtain NTIA frequency allocations, has been prepared in accordance with Part 5 of the NTIA *Manual of Regulations and Procedures for Federal Radio Frequency Management*. The plan, LLNL publication UCRL-AR-110976, documents LLNL's continued justification of need for a trunked system, describes the system, and outlines preliminary system plans and specifications. The telecommunications plan is intended to verify that organizations have considered their requests carefully and have obtained local management support. The DOE has used the plan to defend LLNL's request for allocations at a national level. This document was reviewed by LLNL, DOE-OAK and DOE-HQ before submission to NTIA. NTIA has approved the request as outlined in the plan—an important milestone because DOE orders require that allocations be approved before the project can be funded—and the process of finding available channels and assigning frequencies to LLNL has begun. To date, almost all the required licenses have been received.

Conceptual Design Report

The project Conceptual Design Report (CDR), LLNL publication UCRL-AR-118778, was prepared in compliance with DOE Order 4700.1 and documents the need for an improved radio communication system, outlines the proposed system, and details the cost estimates for equipment and management as well as the methods used to arrive at the estimate. The present CDR is a revision of the original project CDR, which reflected the project scope and line-item funding assumptions as of its release in November, 1992. The CDR—revised in October 1994 to reflect the change in funding strategy to lease-to-own from line item—and this management plan complement each other: the CDR outlines the schedule and management structure but documents in detail the methods used to arrive at cost estimates, whereas this plan discusses schedules and management structure in detail while merely summarizing costs for completeness.

The CDR has been reviewed by technical personnel among key user groups as well as by division leaders within the LLNL Electronics Engineering organization. A

review copy has also been forwarded to the DOE-OAK project manager. Cost estimates have been reviewed by LLNL management at the highest levels. In particular, the funding strategy (pursuing an LTO acquisition to permit use of operating, rather than capital, dollars) have been reviewed by both the LLNL Capital Assets Management Working Group and the Business Management Working Group with final approval given by the LLNL Senior Management Council. The headquarters office of the DOE has also concurred with the proposed purchase strategy.

Functional Requirements

As previously described, required features and performance criteria will be developed jointly by the LPM and the steering committee with input from other affected user groups. User requirements will be reviewed and a functional requirements document prepared that describes system features and capabilities. This document will be approved by the LPM and steering committee with concurrence by the DOE-OAK project manager. This document will be incorporated into the request for proposals and procurement specification.

Acceptance Test and Standards

The Acceptance Test and Standards document, equivalent to a quality assurance plan for this project, will also be compiled by the project team and incorporated into the procurement specification. The document will spell out backbone acceptance test procedures and include detailed check lists for technicians to follow. Each check list will have on it a signature space for the individual responsible for the test to indicate test completion, and relevant technical data. Major tests will be witnessed by both the LLNL project team and vendor representatives. The Acceptance Test and Standards plan will, in addition, establish installation standards and specify test documentation and record-keeping requirements. Also included will be discussions of environmental conditions at the sites, grounding and lightning protection, and discussions of the technical review process to be conducted at each stage. Also to be included as part of system test and acceptance are project closeout requirements, that is a definition of when the project will be considered complete. Checklists will include, among other items, delivery of as-built documentation, test results, and “punch list” items revealed during final inspections as needing correction.

Migration Plan

The Migration Plan will detail procedures for transfer of user groups to the new system, establishment and management of talk groups, and removal of existing systems. Establishment of talk groups must be considered because only those user groups identified as requiring the coverage afforded by the trunked radio system are slated to move from conventional operation. Also, attention must be paid to the number of groups permitted on the system—an excessive number of small talk groups can load the system and possibly cause queueing. Written procedures for the

establishment of talk groups will be included in the migration plan to the extent practical, but these must remain flexible and will be subject to change as experience is gained. The steering committee will approve the migration plan.

Reports and Reviews

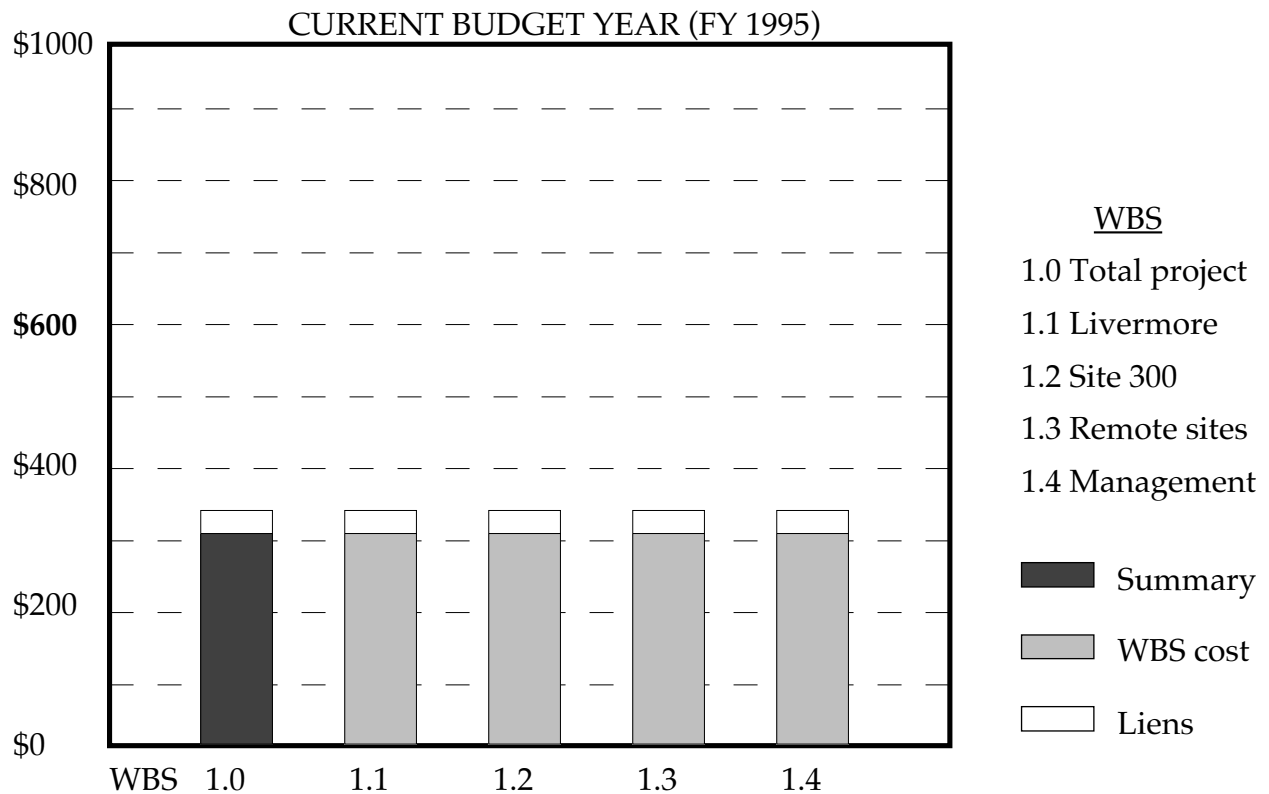
The LPM will issue a monthly project status report for the DOE-OAK project manager by the 20th of each month (subject to the availability of LLNL accounting data) with copies distributed to interested parties at LLNL. The monthly report will include a general project description and summary (narrative) descriptions of major accomplishments, major activities, and concerns potentially affecting cost or schedule. Project status reports will include time lines for each WBS item, showing activities in progress and completed, and will follow a bar-chart format similar to that of Fig. 5. Solid arrows will be used to denote each project milestone, while any revisions to milestone completion dates will be denoted by outline arrows shown on the chart beginning in the month that changes become known.

Cost information, presented in the format of Fig. 9, will be included in the monthly report and will show current-year costs and liens (as practical) broken down to WBS level 2. By showing liens, the LPM can take into account the costs of procurements before they appear in the cost reporting system as direct charges. The bar chart form of Fig. 9 was chosen for financial reporting over the linear graph customarily found in reports for construction-type projects because (unlike construction projects) progress on an LTO project is not reflected by the amount of money spent. For an LTO, the bulk of the cost—that is, payments on the lease—does not correspond to the bulk of the work. Equipment will be received and test and installation efforts will commence long before lease payments begin. Therefore, focusing on current year LLNL labor spending gives the most accurate picture of progress and effort; coupling these figures with LTO procurements and liens gives a complete indication of present and anticipated obligations.

Formal and informal technical reviews will be held periodically at LLNL as deemed necessary by the LPM. At formal design reviews, technical personnel within and (at LPM discretion) outside the Laboratory will review the system technical design. The DOE-OAK project manager will be notified in advance of formal technical reviews. The LLNL project team will prepare and distribute minutes from formal reviews. In addition to formal reviews, informal technical discussions and meetings will be held among members of the project team to solve problems as they arise and to address and validate technical issues at more detail than would be appropriate for monthly reports.

Informal discussions between the LPM and DOE will supplement formal reports and will help ensure that all players remain fully aware of the status of project activities. In addition, the LPM will provide the DOE-OAK project manager with information needed when the DOE project manager needs to make presentations or reviews within his organization or to headquarters.

COST AND ASSESSMENT
MULTI-SITE TRUNKED RADIO PROJECT
Through 10-31-94



HISTORY (dollars in \$K)

FY	1994	1995	1996	1997
Allocated	\$216	\$590	\$1438	\$1455
Spent	\$212			

ASSESSMENT – Current year

	OCTOBER	NOVEMBER	DECEMBER	JANUARY
Schedule	<div></div>	<div></div>	<div></div>	<div></div>
Cost	<div></div>	<div></div>	<div></div>	<div></div>

Satisfactory
 Minor Concern
 Major Concern

Figure 9. Format for presentation of project cost information in monthly reports.

